SILVA BALCANICA

Silva Balcanica 21(1): 77–82 (2020)
doi: 10.3897/silvabalcanica.21.e54605

RESEARCH ARTICLE

Dynamics of populations of pine processionary moth (*Thaumetopoea pityocampa*) in the Republic of North Macedonia during the period 2007-2017

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Academic editor: M. Georgieva | Received 10 March 2020 | Accepted 12 April 2020 | Published 30 June 2020

Citation: Nacheski S., I. Papazova-Anakieva, S. Lazarevska, B. Shurbevski (2020) Dynamics of populations of pine processionary moth (*Thaumetopoea pityocampa*) in the Republic of North Macedonia during the period 2007-2017. Silva Balcanica 21(1): 77–82. https://doi.org/10.3897/silvabalcanica.21.e54605

Abstract

This study presents results for the dynamic of the populations of the pine processionary moth (*Thaumetopoea pityocampa*) during the period 2007-2017 and the impact of reducing factors in the Republic of North Macedonia. The population density was determined by the number of larval nests both per tree and per hectare that varied during the research period. The number of individuals went up between 2007 and 2010, while during the following years it rapidly decreased. Since 2011, an overall prograding trend has been recorded in the several subsequent years. This could be explained by the huge number of individuals from the previous years that were in a diapause. The abundance of pest populations continued to grow in 2016 as no measures were taken. During the winter of 2016/2017, the impact of the extremely low temperatures on pest mortality was monitored in 2016-2017 generation. The density of the populations came to latency due to the very large number of dead larvae of second and third larval stages. We recorded a 100% mortality of larvae in plantations of *Pinus nigra* in the regions near Prilep, Sveti Nikole, Shtip, Kochani and Negotino Villages.

Keywords

Thaumetopoea pityocampa, *Pinus nigra* forests, mortality, low temperatures

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Introduction

The pine processionary moth, *Thaumetopoea pityocampa* (Denis, Schiffermüller, 1775) (Lepidoptera: Notodontidae) has been recorded for first time at the end of 1950s in nearly all natural stands of *Pinus nigra* Arn. in the southern part of the Republic of North Macedonia (Serafimovski, 1959; Kusevska et al., 1978). The pest has been also observed from Gevgelija (535 m a.s.l.) to Visoka Cuka (1200 m a.s.l.) and from the Mariovski Basin, where the main area of pest infestation is, to Ligurasa - Tribot - Karavastina at 1200 m a.s.l. In the central part of the country, *T. pityocampa* has reached Skopje. It is occasionally found near Krusevo (1300 m a.s.l.) and to the east - along the border with Bulgaria (Maleshevo Mountain, Golak, Plackovica, Ograzden), and in the west direction - in the region of Bitola, Resen and Ohrid.

In the natural stands, the pine processionary moth is not subjected to a particular threat because of the natural regulation of the populations. As a result, damages caused by the pest have greatly decreased. However, since 1970s, the area of pine plantations attacked by *T. pityocampa* has extended to 160 000 ha and among them 95% of the plantations were *P. nigra* (Ivanov, Nacheski, 2001, 2005; Nacheski, Papazova-Anakieva, 2013). The pest has been registered occasionally also on *P. sylvestris* L., *P. peruke* Gris., *P. brutia* Ten., *P. pinaster* Ait. and *Pseuodotsuga menziesii* (Mirb.) Franco (Nacheski, Papazova-Anakieva, 2015).

During the last decade, as a result of global warming, *T. pityocampa* has enlarged its range and has been registered for the first time in the locality Zmiski Rid near Kumanovo (2009) as the most northern location, with high abundance on the area of 500 ha in 2010 (Nacheski, Papazova-Anakieva, 2015).

The aim of this study was to explore the population dynamics of *T. pityocampa* and the impact of limiting factors on its survival in the Republic of North Macedonia.

Materials and Methods

The studies were carried out during the period 2007-2017 at 11 localities where *T. pityocampa* is found. The study area encompassed seven regions (Vinica, Kochani, Kavadarci, Sveti Nikole, Prilep, Bitola and Negotino) of North Macedonia (Table 1).

Standard methods for evaluating the abundance of *T. pityocampa*, assessment of attack intensity and for degree of damage to trees, were used in selected stationary experimental plots (25 x 25 m) in plantations of *P. nigra*. The abundance of the pest was determined according to the number of larval nests on trees in the experimental plots and calculated per hectare. The mortality of larvae owing to the extremely low temperatures in the winter of 2017 was established by dissection of 10-15 larval nests from each locality.

The laboratory studies were carried out in the entomological laboratory of the Faculty of Forestry in Skopje.

Table 1. Main characteristics of the studied areas

Region/Site	Coordinates	Altitude, m a.s.l.	Host plant
Vinica Bandedra	41°52'36.62"N, 22°30'49.11"E	500	*Pinus nigra*
Vinica Prevalec	41°55'30.91"N, 22°28'14.35"E	484	*Pinus nigra*
Kochani Belski Rid	41°56'26.69"N, 22°23'06.06"E	600	*Pinus nigra*
Kavadarci Ljubash	41°26'45.98"N, 21°58'54.04"E	427	*Pinus nigra*
Kavadarci Deponija	41°25'03.05"N, 21°59'71.47"E	388	*Pinus nigra*
Sveti Nikole Crnilishki Rid	41°50'16.65"N, 21°55'21.90"E	443	*Pinus nigra*
Sveti Nikole Gorobinci	41°52'39.91"N, 21°52'13.36"E	529	*Pinus nigra*
Prilep Alinci	41°15'51.72"N, 21°28'04.41"E	629	*Pinus nigra*
Prilep Ezero	41°23'27.14"N, 22°35'37.90"E	760	*Pinus nigra*
Bitola Brusnik-Lavci	41°00'56.61"N, 21°17'52.66"E	833	*Pinus nigra*
Negotino Timjanicka Cucka	41°27'28.15"N, 22°06'22.07"E	269	*Pinus nigra*

Results and Discussion

During the period 2007-2017, the pine processionary moth attacked yearly between 3500 and 17280 ha of pine forests in the Republic of North Macedonia (Fig. 1). The population density of *T. pityocampa* varied during the research period. The number of individuals in different populations from the generations 2007-2010 was growing, and then rapidly decreased. This was a result of the control measures taken in 2010, when air treatment with Rimmon E-10 was carried out.

In 2009, there was another outbreak and in May 2010, significant damages were reported. We have monitored the current situation by estimating numbers of nests and the degree of infestation was critical in newly planted pine forests with some regional fluctuations. In the region of Bitola, the numbers ranged from 400 to 20 400 larval nests per ha. In the region of Kochani, the range was from 460 to 19 000 larval nests per ha. We have permanently followed the intensity of attack and population density of the pine processionary moth in all regions of the Republic of North Macedonia, where its presence has been determined.

After 2010, the abundance of *T. pytiocampa* was brought to normal limits in all regions. From 2011, a progradation trend has been recorded as a result of the huge number of individuals which were in the pupae stage during the winter diapause during the previous years. The population density was increasing in the several subsequent years. In conjunction with this, the percentage of defoliation increased almost at all sites in North Macedonia from 2011-2015. Based on the results obtained in this period and predominantly due to the very high population density, recommendations were given with measures for gradual regulation of the populations of the pine processionary moth in plantations of *P. nigra* in 2015 and 2016.

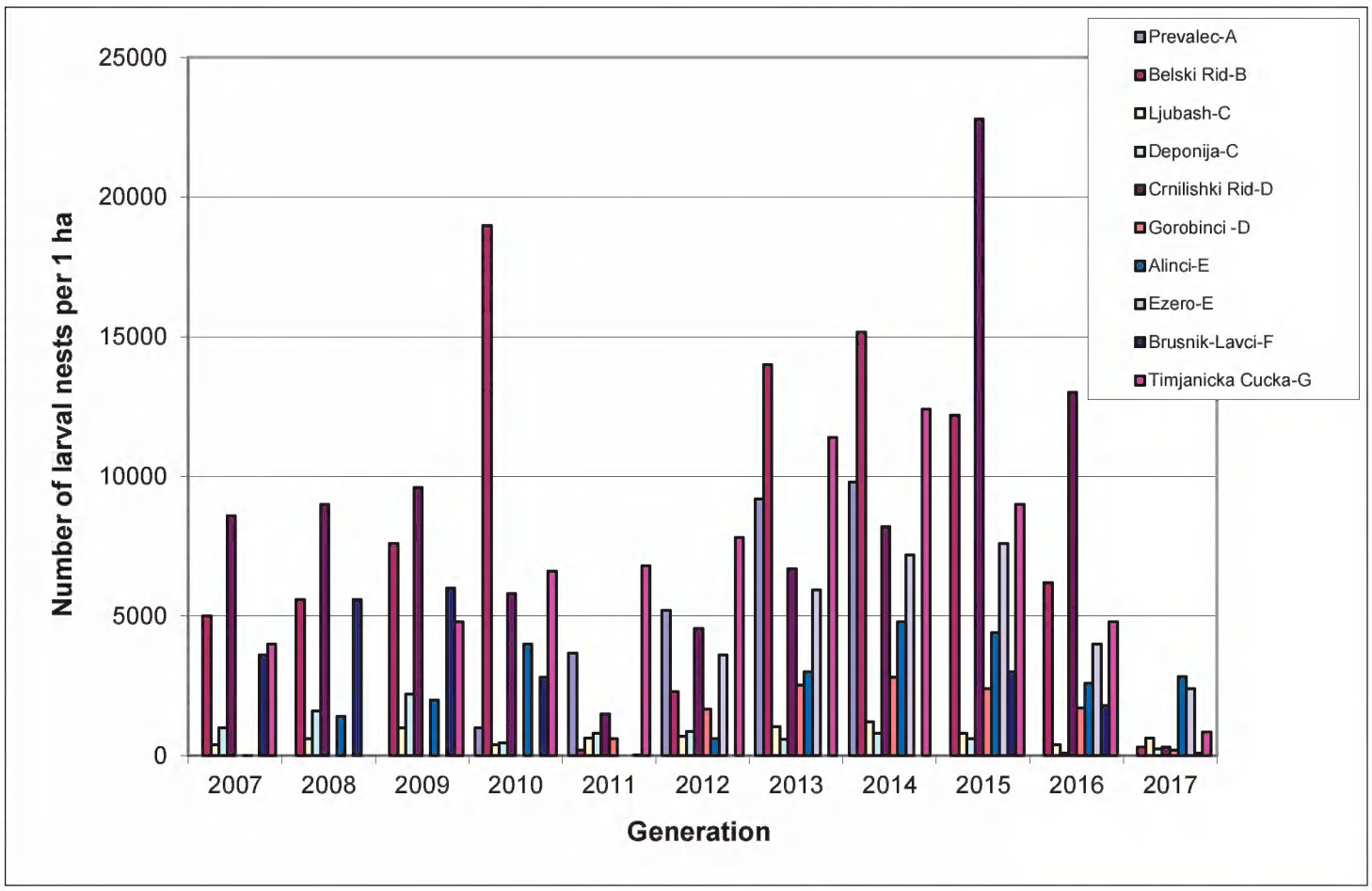

Figure 1. Abundance of the pine processionary moth for the period 2008-2017 in the Republic of North Macedonia: A – Vinica; B – Kochani, C – Kavadarci; D – Sveti Nikole; E – Prilep, F-Bitola; G – Negotino

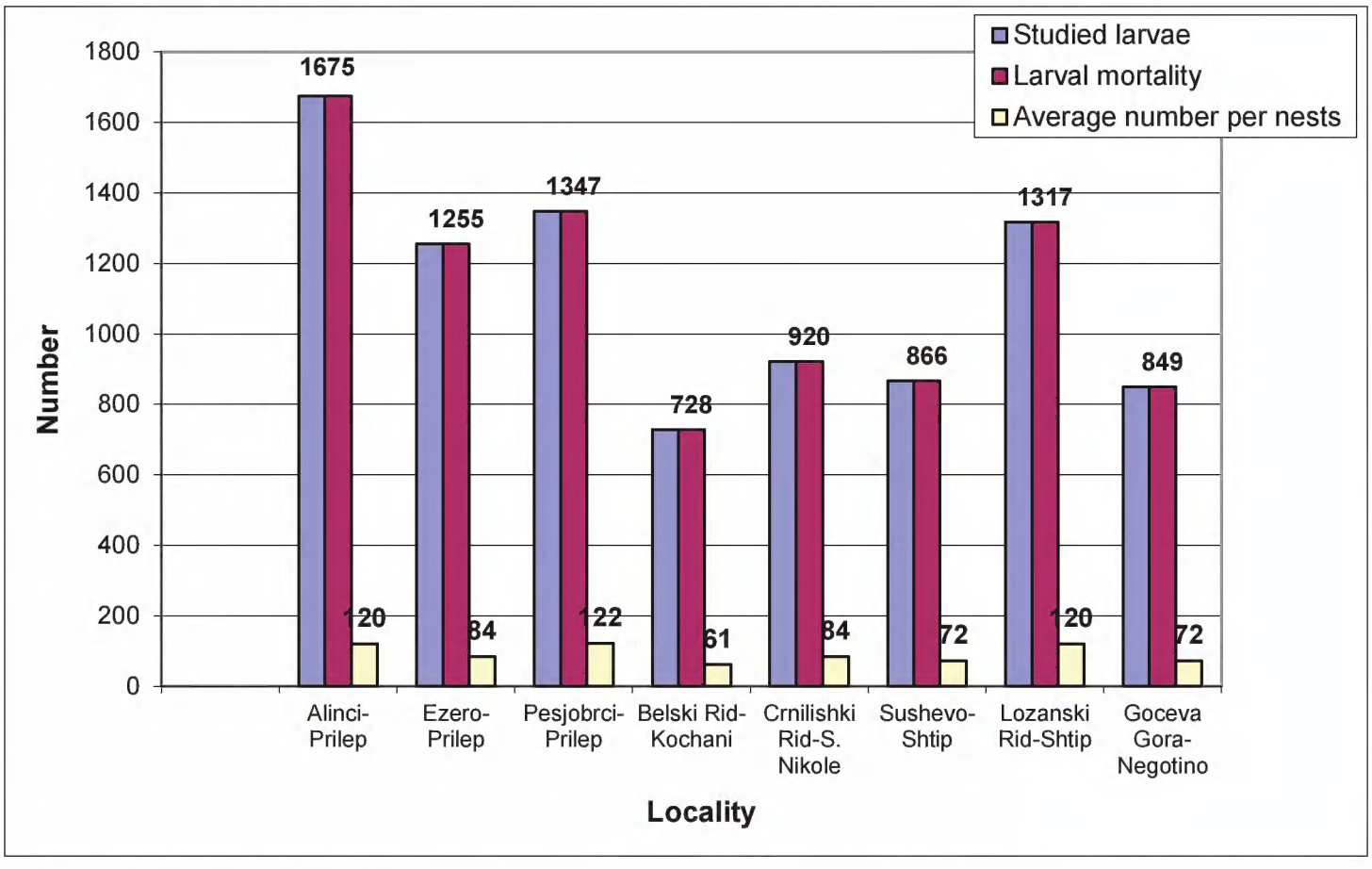

Figure 2. Larval stages of *Thaumetopoea pityocampa* at the time of death

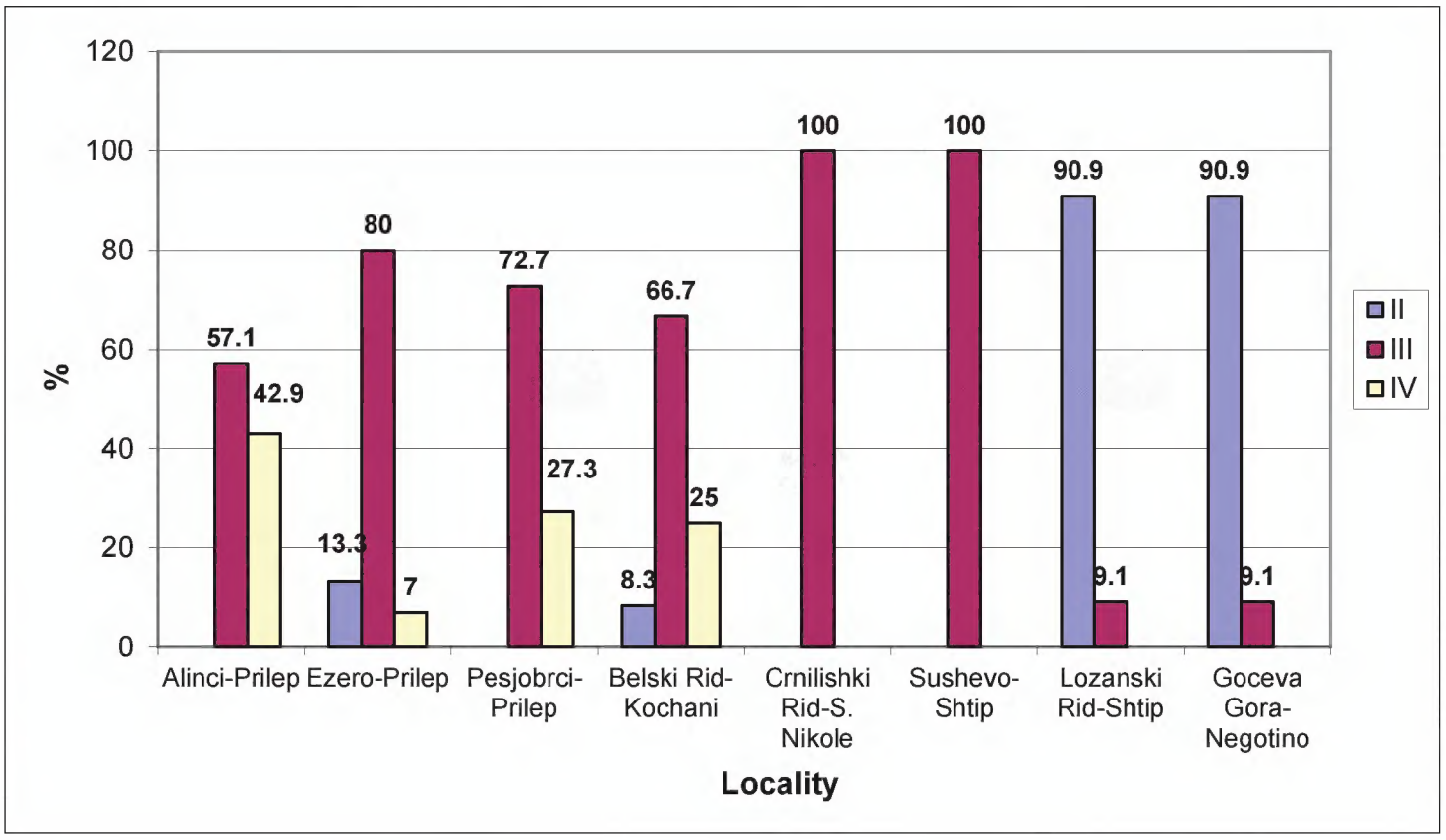

Figure 3. Larval mortality of the pine processionary moth in the winter of 2016/2017

Because no corrective measures were taken, the abundance of populations of *T. pityocampa* continued to rise in 2016. In the winter of 2016/2017, we recorded a pronounced retogradation.

The population density of *T. pityocampa* came to latency due to the very large number of dead larvae. That was owing to the extremely low temperatures that were measured for a long period in January 2017.

In different localities, the predominate part of dead larvae were in the stage of third instars (from 9.1 of loc. Lozanski Rid – Shtip, Goceva Gora – Negotino till 100% of loc. Crnilishki Rid S. Nikole Sushevo – Shtip), followed by second (from 8.3 of loc. Belski Rid - Kochani till 90.9% of loc. Lozanski Rid -Shtip, Goceva Gora - Negotino) and fourth instasr (7.0 – of loc. Ezero -Prilep - 42.9% of loc. Alinci -Prilep), respectively (Fig. 2).

During this research, we identified 100% mortality of larvae of pine processionary moth in the black pine plantations in the studied regions (Fig. 3).

Notable mortality of larvae of *T. pityocampa* as a result of low winter temperatures was also registered in the winter of 2005-2006 (unpublished). The mortality of larvae of pine processionary moth as a result of the low temperature in the winter of 2005-2006 were: from 17.8% in the location Goceva Gora – Negotino, 42.8% in Belski Rid - Kochani up to 99.9% in the locality Alinci – Prilep.

In conclusion, it should be noted that the low winter temperatures in some years are the main limiting factor of pine processionary moth in the Republic of North Macedonia.

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